WIND ENERGY ECONOMICS

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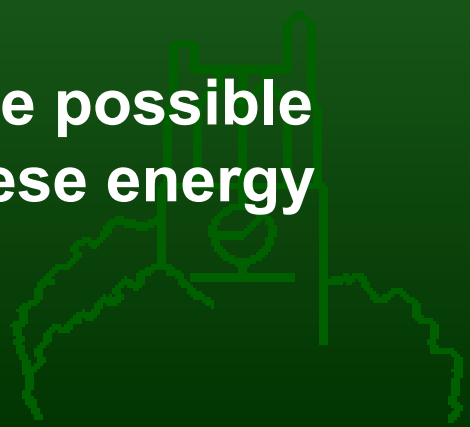
INTRODUCTION

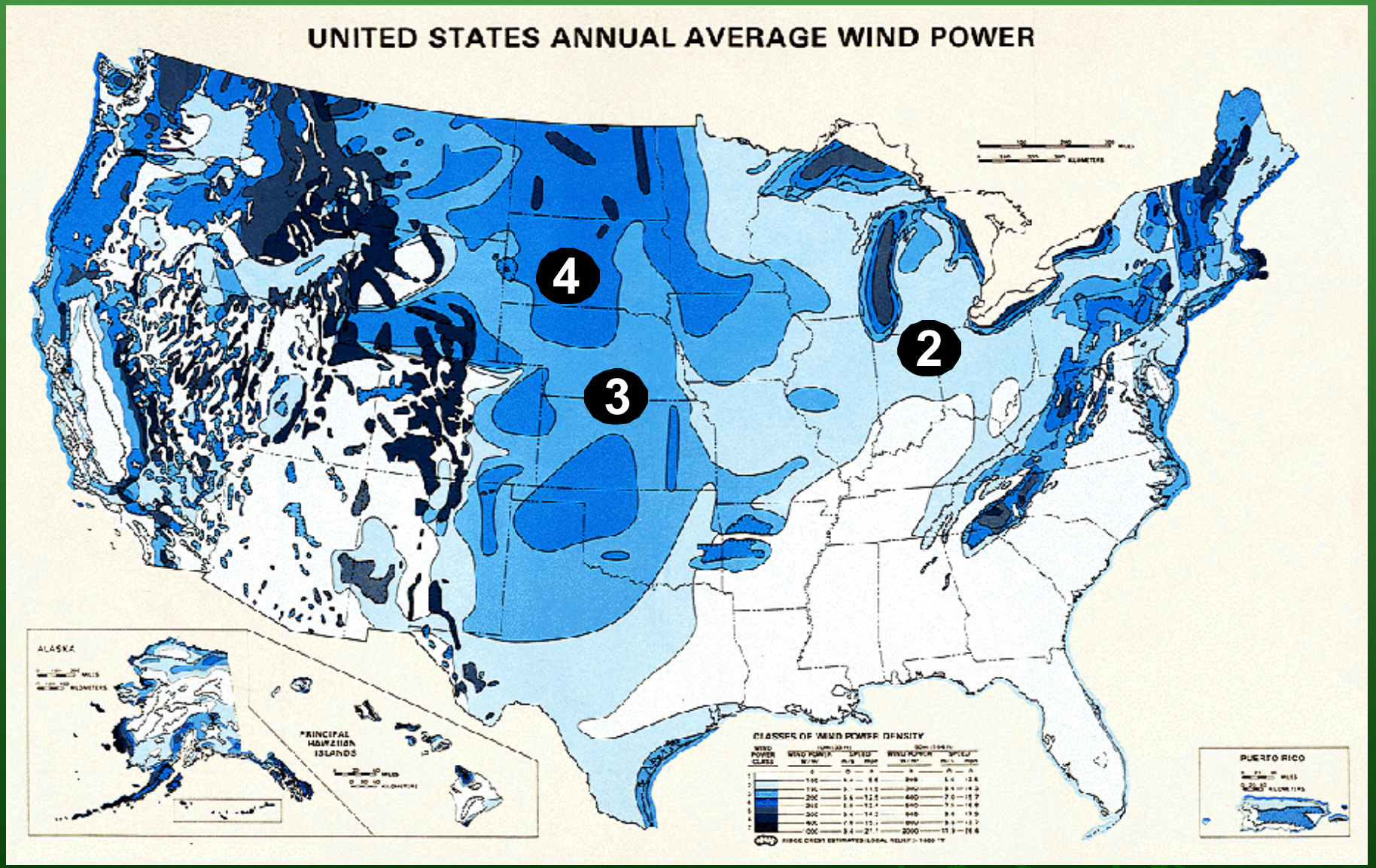
- To acquaint you with the proven economic tools and methods for evaluating capital investments
  - – Cash-flow analysis and discounted returns
  - – Accounting for tax effects
- Review key factors that should be considered in exploring wind economics
- Use case examples to illustrate the possible economic returns by investing in these energy enterprises



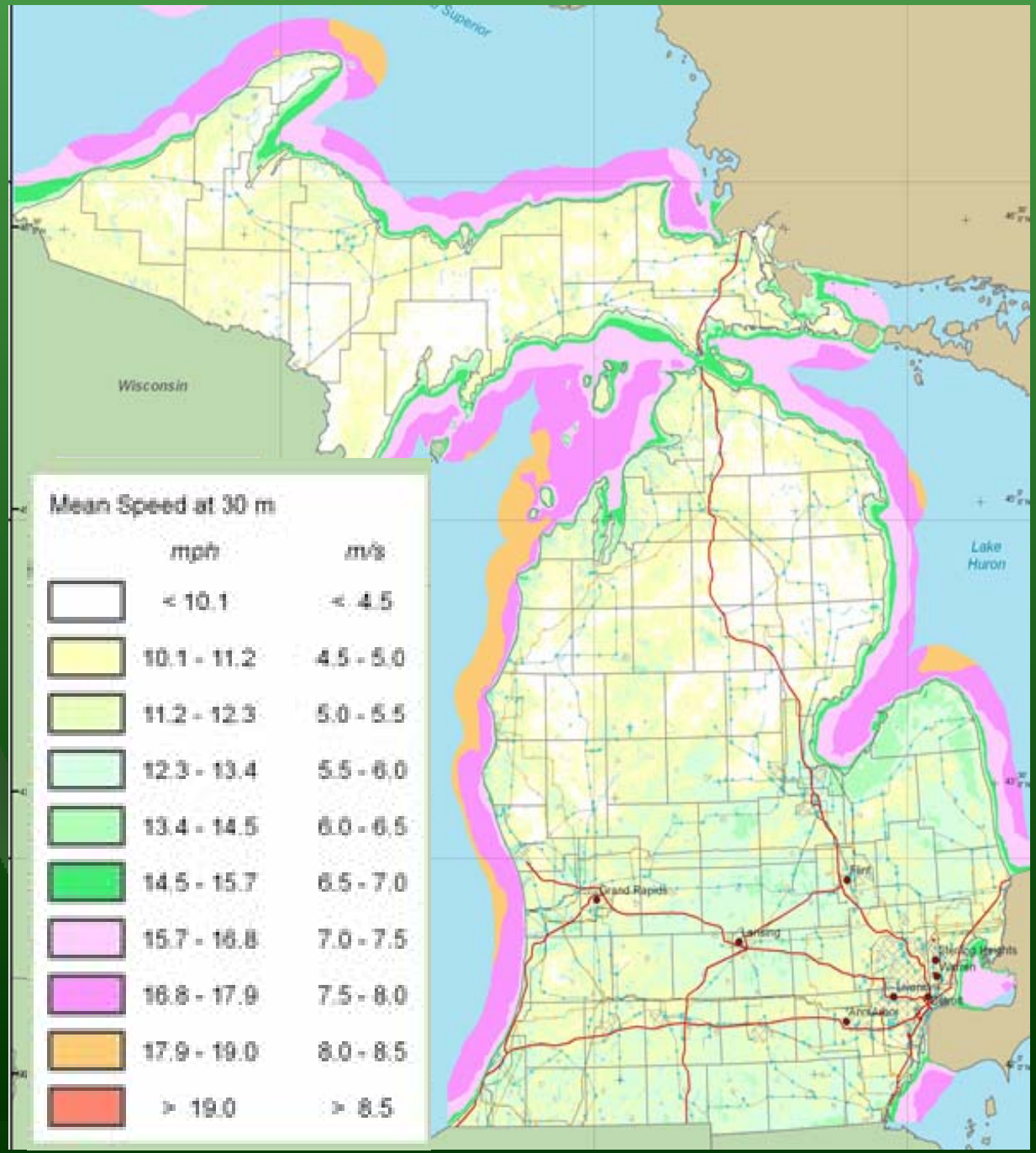
NECESSARY FACTORS FOR TURBINE DEVELOPMENT

- A good source of wind
  - Wind is solar energy
    - The potential power of wind is influenced by:
      - The speed (velocity) of the wind
        -- As the speed increase by 25%, the power increases by 100%
        -- 15 mph to 18 mph results in a 73% increase in power
      - Influenced by height above the ground and obstructions
      - The density (specific gravity) of the air
        -- The air is more dense in the winter months
        -- Higher humidity air is more dense

UNITED STATES ANNUAL AVERAGE WIND POWER



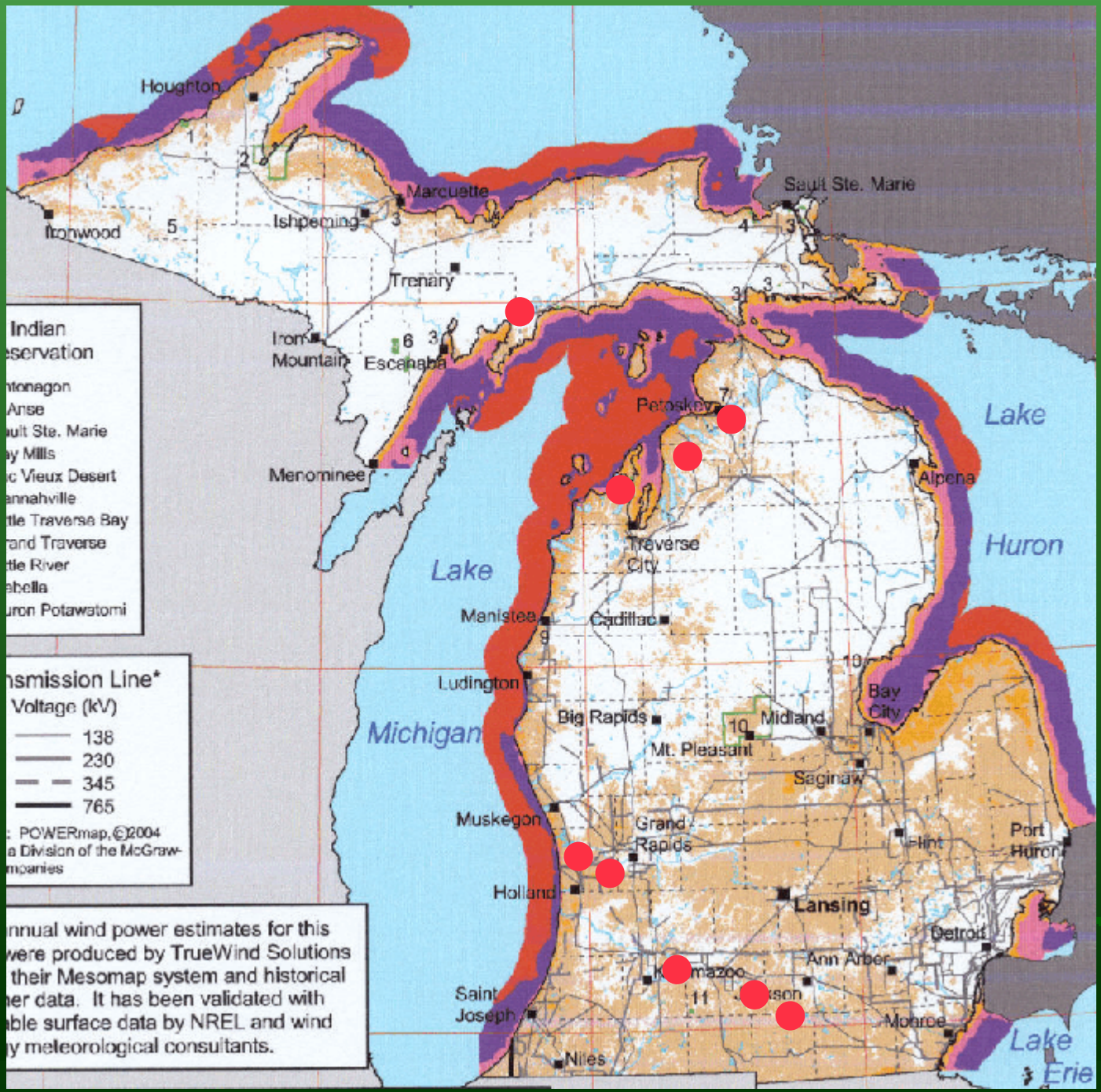
Michigan Wind Speed at 30 Meters (100 feet)

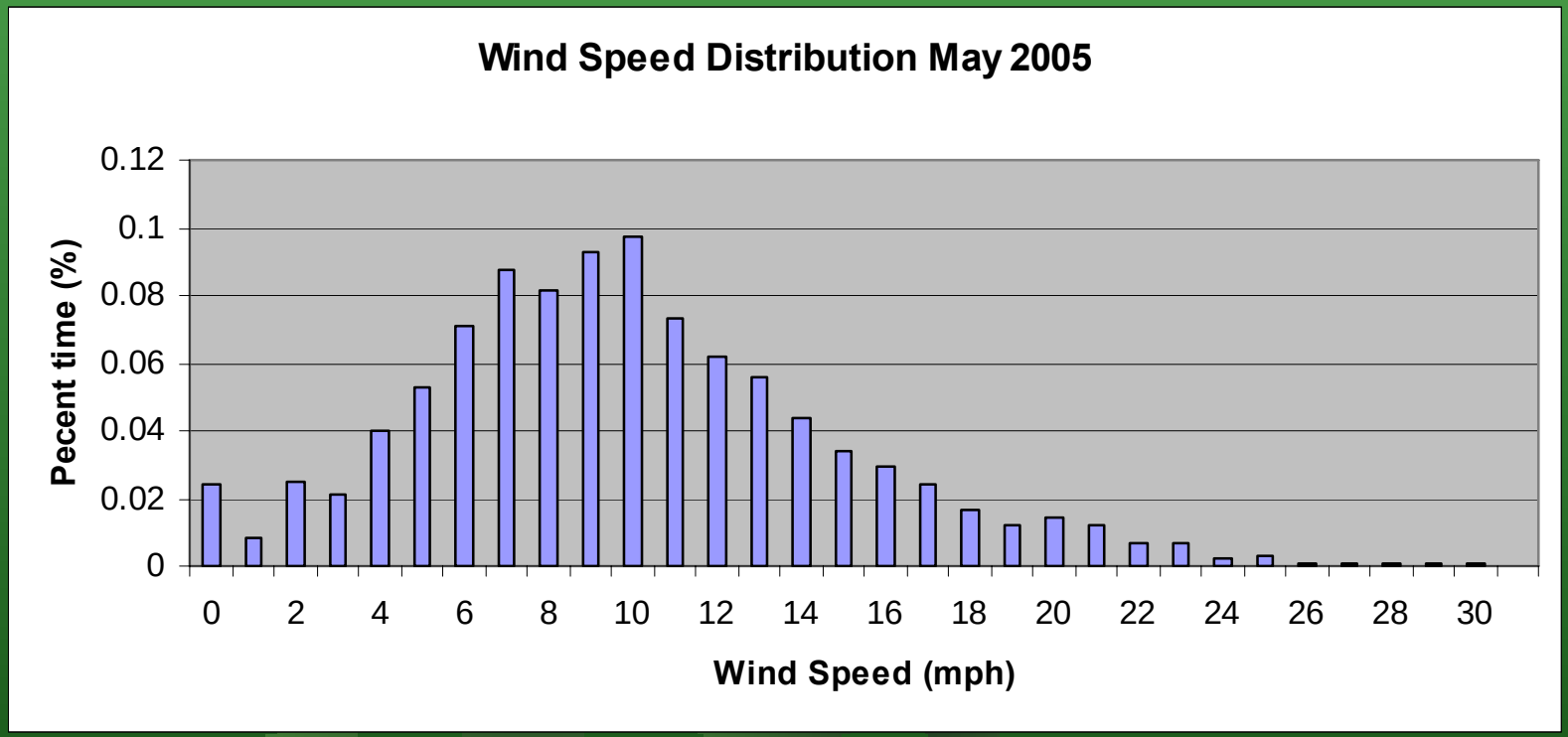


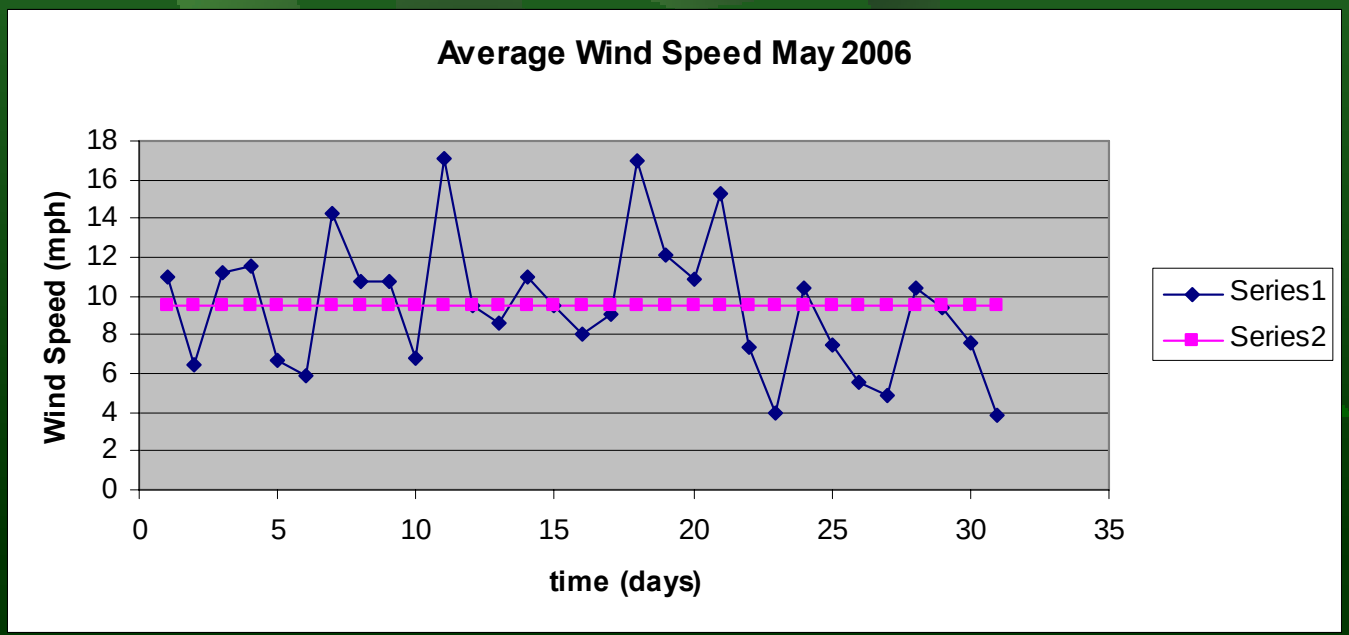
ANEMOMETERS ARE USED TO MEASURE WIND

(Anemometers Continued)

- Anemometer Loan Program for small wind projects
  - Supported by 3 separate grants
  - An application process was used
  - Had over 40 applications
  - Those selected
  - Proposed good use of wind power
  - Appeared to have a good location
  - Reflected some diversity in location and type of agricultural operation
  - Beef, Pork, Dairy, Greenhouse, Fruit operations and research and educational centers
- For utility scale projects a higher anemometer system is needed


Houghton
Marquette
Sault Ste. Marie
Ironwood
Ishpeming
Trenary
Iron Mountain
Escanaba
Menominee
Petoskey
Alpena
Lake
Huron
Traverse City
Lake
Michigan
Manistee
Cadillac
Ludington
Bay City
Big Rapids
Midland
Mt. Pleasant
Saginaw
Muskegon
Grand Rapids
Flint
Port Huron
Holland
Lansing
Detroit
Ann Arbor
Saint Joseph
Monroe
Niles
Lake Erie
Indian
eservation
ntonagon
Anse
ault Ste. Marie
y Mills
c Vieux Desert
annahville
ttle Traverse Bay
rand Traverse
ttle River
ebella
uron Potawatomi
nsmission Line*
Voltage (kV)
138
230
345
765
POWERmap, ©2004
a Division of the McGraw-
mpanies
nnual wind power estimates for this
were produced by TrueWind Solutions
their Mesomap system and historical
er data. It has been validated with
ble surface data by NREL and wind
y meteorological consultants.


Wind Speed Distribution May 2005
Pecent time (%)
0.12
0.1
0.08
0.06
0.04
0.02
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Wind Speed (mph)


Average Wind Speed May 2006
Wind Speed (mph)
18
16
14
12
10
8
6
4
2
0
0 5 10 15 20 25 30 35
time (days)
Series1
Series2

(Necessary Factors Continued)

- **Power purchase agreement**
  - One of the most critical issues
    - It will be the difference between a good investment and a possible bankrupt one
  - The are lots of ways the rate can be set
    - Use the power generated in own business
      - Net metering
    - Negotiate with a power company

      -- Strongly suggest the use of an experienced utilities lawyer
    - Some utility companies have a need or desire to purchase “Green Energy” (RPS = Renewables Portfolio Standard)
    - Take the mandated “avoided cost rate,” currently at 1.8 cents/kwh

(Necessary Factors Continued)

- Access to the grid
  - For smaller systems net metering provisions are supposed to make this easier by it limited to 30kW for Michigan
  - For larger systems, it can be a much more involver process
    - MISO (Midwest Independent Transmission System Operator) controls this access in the Midwest
      - -- Must submit a service request
      - -- Can be a long and expensive process

(Necessary Factors Continued)

- **Have a sound financial plan**
  - Have adequate financing available (short-term and long-term)
  - Need to take advantage of special options
    - Government cost sharing
      - '02 Farm Bill, Title 6401(Section 9006) allows for 25%, max of $500,000
    - Tax effects
      - Fast depreciation
      - Tax credits

(Necessary Factors Continued)

- Local approval
  - There can be significant local resistance
    - Zoning that address set-backs, noise, removal provisions, etc.
    - NIMBY forces
      - Turbine envy
      - Opposed because of the impact on the view, noise, bird kill, ice shed, safety issues, etc.

KEY INFORMATION NEEDED WHEN EVALUATING INVESTMENTS

- Cash flows over time
  - Partial budgeting method

    -- What are the revenues and expenses that change as a result of this investment each year of the life of the investment
  - Need to take into consideration several aspects including
    - Tax impacts
    - Risk
    - Non-time neutral rate changes in cash-flows (inflation)
- A rate of return desired on the investment .

RATE OF RETURN CONSIDERATIONS

- **Payback period**
  - How long does it take to get your investment back
  - Poor way of evaluating investments
- **Some stated goal**
  - At least 15% on invested capital
- **Cost of borrowed capital**
  - This short-changes the investor
  - Which loan should be used
- **Opportunity cost**
  - What can it earn in the next best alternative
    - Farm Land in Michigan = 10.3%
    - Stock Market = 12.7%

DISCOUNTING PRINCIPLE

$$V = \sum_{n=1}^{N} \frac{R_n}{(1+I)^n}$$

Where:

- V = Net Present Value
- R_n = Net return in time period n
- I = Interest rate (decimal form)
- N = Number of time periods for life of investment

$$V = \frac{R_1}{(1+I)^1} + \frac{R_2}{(1+I)^2} + \frac{R_3}{(1+I)^3} + \cdots + \frac{R_n}{(1+I)^n}$$

(Discounting Principle Continued)

EXAMPLE: Two $100,000 investments with different cash flows over time

Discount Rate (Desired Return) = 10%

Investment A

Year	Net Return
0	-100,000
1	5,000
2	10,000
3	15,000
4	20,000
5	25,000
6	30,000
7	25,000
8	10,000
Salvage	15,000
TOTAL	55,000

Investment B

Year	Net Return
0	-100,000
1	25,000
2	30,000
3	25,000
4	20,000
5	15,000
6	10,000
7	5,000
8	5,000
Salvage	10,000
TOTAL	45,000

(Discount Principle Continued)

Year	Discount Factor	Investment A Cash Flows	Investment A Disc. Flows	Investment B Cash Flows	Investment B Disc. Flows
0	1.0000	-100000	-100000	-100000	-100000
1	0.9091	5000	4545	25000	22727
2	0.8264	10000	8264	30000	24793
3	0.7513	15000	11270	25000	18783
4	0.6830	20000	13660	20000	13660
5	0.6209	25000	15523	15000	9314
6	0.5645	30000	16934	10000	5645
7	0.5132	25000	12829	5000	2566
8	0.4665	25000	11663	15000	6998
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		55000	-5311	45000	4486

Internal Rate of Return	8.8%	11.5%

TAX IMPACTS ARE IMPORTANT

- Depreciation allowance
  - This is a non-cash expense
  - It only has value in that it reduces the amount of taxes paid
  - Fast depreciation methods are generally preferred
- Some expenses are tax deducible and others are not
  - Example of tax deducible expenses: Interest on loans, hired labor, repairs, property taxes (reduce taxes paid)
  - Examples of non-tax deducible expenses: Principal on loans (paid with after-tax funds)

(Tax Impacts Continued)

- Tax credits and grants
  - Credits are after-tax funds (have value if taxes are to be paid and are more valuable than a tax-deducible expense)
  - Grants are good because they generally come early but they are taxable income

UTILITY SCALE SYSTEMS

EXAMPLE OF UTILITY SCALE PROJECT

- This is community wind project with eight 1.5 mW turbines in the project
- Key assumptions for a turbine (Case 1):
  - Total cost per turbine is 2.2 million dollars
  - Assumed life of investment = 20 years
  - Power purchase agreement = 6.0 cents per kWh
  - Federal tax credit of 1.9 cents per kWh for 10 years
  - Average power capacity factor for each turbines = 30%
  - Financing 60% of the cost (15 year loan @6.5%)
  - Major rebuild of gear box every 5 years
  - Annual costs include repairs, utilities, property taxes, insurance and service contract
  - Before tax desired return on investment = 12%
  - Aggregate marginal tax bracket = 41%
  - Prior taxable income of 640,000 & $182,000 taxes paid

(Utility Scale Project Continued)

- Analyzed with the "Alpha-3" version of Utility Wind Investment Model (used capital budgeting methods)
  - Uses after-tax discounted flows
- Results (Case 1):
  - Years with negative after-tax cash flows = 3
  - After-tax discounted income = $169,000
  - Before-tax internal rate of return = 16.6%
- Sensitive analysis – Examining alternative scenarios
  - Changing assumptions to determine how they affect the outcome
  - Powerful planning tool
  - Identified what is really important when considering an investment decision

(Utility Scale Project Continued)

- Family owned turbine (Case 2)
  - Assumptions:
    - Same as Case 1 except
    - No lease payments
    - Much lower taxable income and taxes paid
  - Results (Case 2)
    -- Discounted income = $-55,000
    -- Before tax return on investment = 10.8%
    -- Years with negative after-tax cash flows = 4

(Utility Scale Project Continued)

- Minnesota Flip Ownership
  - First 10 years owned by a high tax corporation
  - Second 10 years owned by farm family

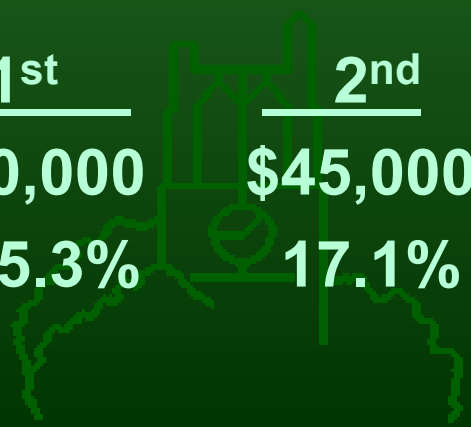
    -- Purchase price =$1,000,000
  - Assumptions (same as Case 1 except):

    -- Family ownership uses assumptions of Case 2

    -- Family obtains only 1% of sales in first 10 years

Results:

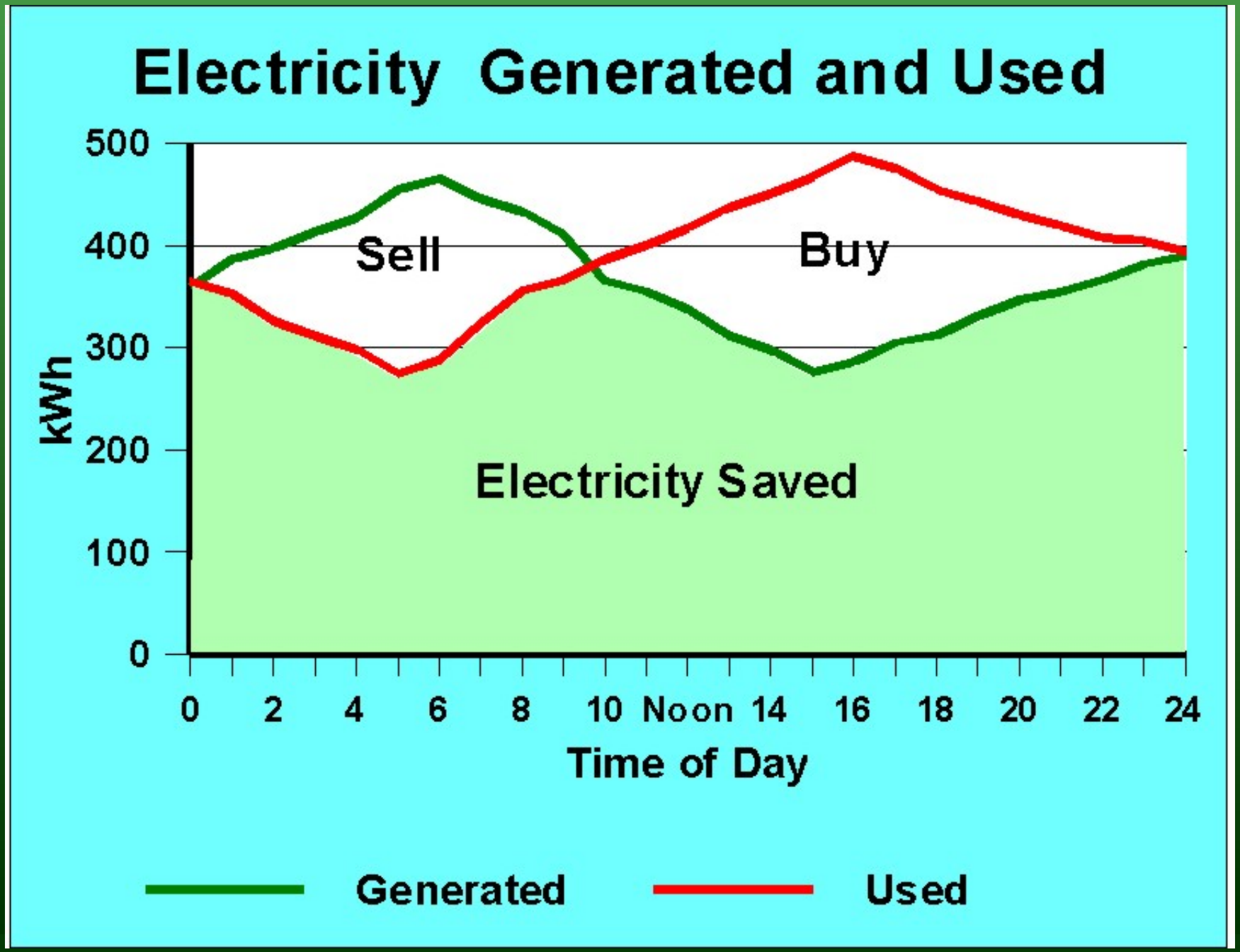
	1st	2nd
Discounted Income	$130,000	$45,000
After tax return on invest.	15.3%	17.1%



SMALL WIND SYSTEMS FOR INTERNAL CONSUMPTION

Used
60 kW
System
Purchased
over
Internet

Less
Than
$30,000
Installed


Electricity Generated and Used
500
400
300
200
100
0
kWh
Sell
Buy
Electricity Saved
0
2
4
6
8
10
Noon
14
16
18
20
22
24
Time of Day
Generated
Used

ECONOMICS OF SMALL WIND SYSTEM (CASE 1)

Key assumptions:

- Total cost of project is $36,000
- Assumed life of investment = 25 years
- Power purchase agreement = 3.3 cents per kWh
- Before installing system, purchased 130,000 kWh of electricity at 8.8 cents/kWh
- Average power capacity factor = 20%
- Proportion of business potential not usable = 20%
- Financing 60% of the cost (15 year loan @6.5%)
- 25% cost share under Section 9006
- Annual costs include repairs (higher rate), utilities, property taxes and insurance, service contract
- Aggregate marginal tax bracket = 41%

(Small Wind System Economics Continued)

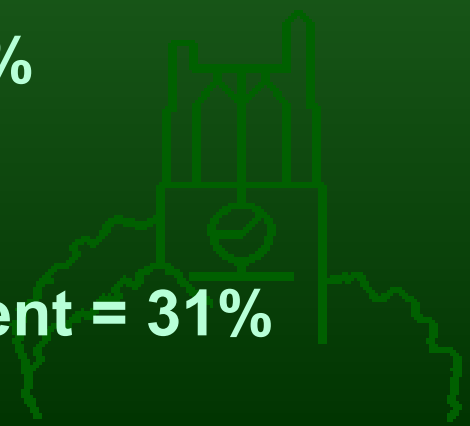
- Analyzed with the Small Wind Investment Model
  - Used after-tax discounted flows
- Results (Case 1):
  - Net Present Value = $13,688
  - Number of years with negative after-tax cash flows = 4
  - First couple of years have negative operating losses
  - Before-tax internal rate of return = 49%

SMALL WIND PROJECT (CASE 2)

- Purchase of same system but generator rewound for only 30 kW to meet Michigan's net metering requirement
  - Same as Case 1 except:
    - Capacity is only 30 kW
    - Cost of system is $4,000 more to cover rewiring cost
    - Slightly lower repair costs
    - Higher capacity factor of 22% (slight lower quality wind but smaller generator)
    - Only 5% of potential capacity not used by business
    - Net metering with $0.105/kW for purchase and $0.06 for net metering buy back

(Small Wind Case 2 Continued)

- Results (Case 2, Scenario 1):
  - Net Present Value = $-1,437
  - Number of years with negative after-tax cash flows = 7
  - First few years have negative operating losses
  - Before-tax internal rate of return = 6.0%
- Case 2, Scenario 2:
  - Same as Case 2, Scenario 2 expect net metering maximum is set at 60kw and 60kW turbine is used
    -- Lower capacity factor of 17%
  - Results:
    -- Net Present Value = $6,886
    -- Before Tax Return on Investment = 31%



CONCLUDING REMARKS

- Investments in value-added energy systems can involve large capital outlays
  - It is important to get the economics correct
  - Considers the time value of money
  - Takes into consideration the tax effects
- Because situations vary, it is important to evaluated each situation independently (use the computer models developed)
- These investments have a fair amount of risk and uncertainty involved
  - It is important to do extensive sensitivity analysis
  - Pay close attention to the key factors impacting the decision, particularly the net metering options